(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 138 503 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 04.05.88

(51) Int. Cl.[4]: B 21 B 27/10

(21) Application number: 84306713.3

(22) Date of filing: 02.10.84

(54) Rolling mill spray bar.

(30) Priority: 11.10.83 US 540964

(43) Date of publication of application: 24.04.85 Bulletin 85/17

(45) Publication of the grant of the patent: 04.05.88 Bulletin 88/18

(84) Designated Contracting States: AT BE DE IT

(56) References cited:
DE-A-1 602 123
DE-A-2 855 906
DE-A-3 146 656
US-A-1 994 721
US-A-3 237 872
US-A-3 802 237
US-A-3 941 611
US-A-4 262 511
US-A-4 312 377

(73) Proprietor: KAISER ALUMINUM & CHEMICAL CORPORATION
865 Kaiser Building 300 Lakeside Drive
Oakland California 94643 (US)

(72) Inventor: Hsu, Yu-Wen
1728 Warsaw Avenue
Livermore California 94550 (US)

(74) Representative: Oliver, Roy Edward et al
POLLAK MERCER & TENCH High Holborn House
52-54 High Holborn
London WC1V 6RY (GB)

EP 0 138 503 B1

Courier Press, Leamington Spa, England.

Description

This invention generally relates to the rolling of metal ingots into sheet and plate products and in particular to an improved liquid application device or spray bar for the application of lubricants or coolants to the surfaces of the workpiece or the work rolls or the backup rolls of a rolling mill, during the rolling process.

In the rolling of metal products, lubricants or coolants (hereinafter called "liquids") are applied to the workpiece or the work rolls or the backup rolls, or all three, in order to control both the temperatures and the frictional properties of these surfaces. Usually, such liquids are applied at both the entry and exit sides of the rolling mill stand.

In commercial rolling mills, the amount of liquid applied and the pattern of liquid distribution on the work rolls are controlled to obtain the thermal gradients which will ensure that the proper crown will be maintained on the work rolls. Without such temperature control, undesirable thermal gradients build up along the length of the roll, causing differential thermal expansion which distorts the crown of the roll and results in differential thickness reductions and tension differences across the width of the workpiece, i.e. unflat sheet or plate.

For most commercial rolling, liquids are directly applied to both the work rolls and the backup rolls through a series of nozzles or clusters of nozzles disposed along the length of the rolls. Each of the nozzles or clusters of nozzles is supplied with liquid from a separate source, which has independently controlled valving means in order to provide the desired liquid distribution on the rolls.

Because of the harsh environment in which these spray devices are used, frequent malfunctions occur causing mill shutdowns or ineffective cooling of the workpiece, the work rolls or the backup rolls which often result in unflat products. The individual valving means can plug up due to the buildup or accumulation of particulate and other debris which frequently accompanies the liquids, in which case little or no liquid passes through to an area of the work rolls which expands due to heat buildup. On the other hand, the valving means can stick open, in which case unwanted liquid flow continues to a particular area of the workpiece or rolls, causing undesirable cooling. Generally, when the control valves are maintained in the area of the rolls and workpiece, they are exposed to a very high probability of damage. The valving arrangement can be removed to a much safer location away from the rolling mill where the chances of damage can be significantly reduced, but this does not avoid having liquid sources and individual valving means for each particular nozzle or cluster of nozzles.

Ideally, commercial spray devices should be durable and have the flexibility to make changes in coolant or lubricant application which are required by changes in the rolling conditions or workpiece characteristics. As an example of the latter characteristic, in the operation of most rolling mills, the workpieces have widely varying widths and in such cases the coolant spray to the work rolls must be controlled to the edge of the workpiece. Coolant on the work rolls beyond the edge of the workpiece is undesirable and should be terminated. Additionally, although there are usually other strip flatness control means provided in a rolling mill, control of liquid distribution over the work rolls and backup rolls is often necessary to correct for or to minimize center buckles, quarter buckles and edge waviness in the workpiece. There have been prior spray devices which allow for a significant number of such changes in coolant or lubricant distribution across the rolls but they have usually not been very durable.

Examples of prior art devices are disclosed in the following patent specifications:

US—A—804,807
US—A—3,237,872
US—A—3,574,338
US—A—3,771,730
US—A—3,802,237
US—A—3,880,358
US—A—3,941,611
US—A—4,081,141
US—A—4,247,047
US—A—4,312,377
DE—A—1,602,123

The aforementioned DE—A—1,602,123 discloses a device for applying liquid to a work roll in a rolling mill, which comprises an elongated housing having a plurality of liquid spray nozzles in fluid communication with conduits, an elongated manifold rotatably mounted within the housing and having an arcuate wall provided with a plurality of apertures in a predetermined array and defining an inner chamber, sealing means between the housing and the manifold, means for directing liquid to the chamber within the manifold and means for rotating the manifold within the housing to align the desired apertures in the arcuate wall with the conduits.

It is against this background that the present invention was developed.

The present invention is directed to an improved liquid application system or spray bar device which is simple and durable, yet flexible enough to control the flow of liquids along the length of the work rolls or backup rolls of a rolling mill in a wide variety of rolling applications.

In accordance with the invention, the liquid application device of the kind described is characterised in that:

(a) the nozzles are arranged to spray liquid on to a roll and/or on to the workpiece,

(b) the sealing means are arranged between the conduits and the outer surface of the arcuate wall of the manifold and are operable for selectively sealing the liquid passageways to the conduits from the interior of the manifold, the sealing

means comprising a sleeve which fits over the manifold wall and includes a plurality of apertures selectively alignable with the conduits normally in fluid communication with the nozzles,

(c) the manifold rotating means comprise a motor for rotating the manifold and a control panel element divided into a plurality of pie-shaped sectors each representing a given width of liquid spray, the sectors being further subdivided into subsectors which represent particular combinations of opened and closed nozzles which provide a selected spray pattern, and

(d) means associated with the panel element for selecting a given sector and thereby effecting a corresponding rotation of the motor and manifold as determined by the selected sector.

The aperture in the arcuate, preferably cylindrically shaped, wall of the rotating manifold are provided in a particular arrangement or array so that, as the manifold is axially rotated, the holes in the wall of the manifold becomes aligned or in register with the conduits which are in fluid communication with the nozzles or clusters of nozzles associated with the exterior of the header. The particular array of apertures in the manifold wall is designed so that, when the manifold is rotated about its axis, the apertures therein, which allow the passage of liquid from within the manifold to the nozzles, are opened or closed, as the case may be, to provide the desired liquid spray pattern required for the particular situation involved in the rolling mill.

Only about 10 to 30 separate liquid application patterns are needed in the operation of most commercial rolling mills, so that the size, the number and the location of apertures in the wall of the manifold can be readily determined. In its simplest form, all of the apertures in the manifold wall for a particular nozzle or group of nozzles are spaced radially from one point on the longitudinal axis of the manifold so that, when the manifold is rotated, coolant can flow from the chamber, defined in part by the manifold, through the aperture in the cylindrical wall thereof to the desired nozzle or group of nozzles only when the apertures in the manifold are in alignment or in register with the conduits which are in fluid communication with the nozzles or clusters of nozzles in the housing. To increase the number of possible combinations of liquid application patterns for a particular manifold diameter, the apertures in the manifold for each nozzle can be slightly skewed so that they rotate in a helical fashion about the axis of the manifold when the manifold is rotated to allow more apertures to be utilized for each particular nozzle or groups of nozzles. However, in this latter case, the manifold must also be moved along its longitudinal axis to ensure proper alignment of the apertures in the manifold with the conduits leading to the nozzles.

The sealing means disposed between the manifold wall and the conduits in fluid communication with the nozzles can be singular element, such as a sleeve which slidably fits over the manifold and which has a plurality of apertures or ports through which the fluid passes to the various nozzles, or the sealing means can be a plurality of individual sealing elements, which are positioned between the apertures in the manifold associated with a particular nozzle or group of nozzles and the port in the exterior housing which is in fluid communication with a particular nozzle or groups of housing nozzles. The sealing element and the surface of the cylindrically shaped manifold wall are urged together and preferably are provided with matching curved shapes (i.e. one concave and one convex) so that a proper liquid-tight seal can be made. The sealing means can be formed of any suitable material, but a coating of polytetrafluoroethylene or other material having a low coefficient of friction is recommended for the surface of the sealing means which is in contact with the matching curved surface of the manifold.

The manifold is journalled or otherwise mounted so that it may be rotated within the housing and it is provided with a suitable drive means to rotate the manifold and thereby align the apertures in the wall thereof to be in fluid communication with the nozzles or groups of nozzles selected.

The operation of the spray bar device of the invention is amenable to automatic control, particularly control based on sensing devices which determine the unflatness of the workpiece downstream from the spray bar. Suitable flatness sensing devices include various types of shape meters and tensiometers which generate one or more signals representing the flatness or unflatness of the sheet or strip and which can be used by control procedures well known to those in the art to control the drive means which rotate the manifold of the spray bar of the invention. A particularly suitable flatness sensing device and method are disclosed in our copending European Patent Application No. 84306480.9—Publication No. 0138430 entitled Process and Apparatus for Strip Flatness and Tension Measurements.

Reference is made to the drawings which illustrate embodiments of the invention. Figure 1 is a perspective view of the spray bar disposed on the exit side of a rolling mill stand adjacent to the upper work roll 11. Figure 2 is an end view of the spray bar. Figure 3 is a top view of the spray bar in section and Figure 4 is a rear view thereof partially in section. Figure 5 is a cross-sectional view taken along the line 5—5, shown in Figure 3. Figure 6 is the same cross-sectional view shown in Figure 5 of another embodiment of the invention. Figure 7 illustrates the cylindrically shaped wall of the manifold which has been slit longitudinally and spread out or flattened. Figure 8 represents a dial for selecting various liquid application arrangements. In the drawings, all corresponding parts are numbered the same.

In Figure 1, the liquid application device or spray bar 10 is suitably supported by means not shown on the exit side of a rolling mill stand, immediately adjacent the upper work roll 11 and above the workpiece 12 leaving the mill stand. Liquid from the spray bar 10 is sprayed on to the

surfaces of the work roll 11. Separate spray bars (not shown) would be used to apply liquid to the lower work roll 11, the upper and lower back up rolls 13 and possibly the workpiece 12. Nozzles 14 spray liquid in the particular pattern desired on to the surfaces to be cooled. A conduit 15 directs liquid coolant and/or lubricant from a source (not shown) to the inside of the spray bar housing 16.

The internal and working details of the spray bar 10 are more completely illustrated in Figures 2—5, where the cylindrically shaped manifold 19 is shown rotatably mounted within the housing 16. The manifold 19 is provided with a plurality of apertures 20, which are disposed in a particular array in its cylindrical wall 21. However, not all of the apertures 20 in the manifold 19 are shown in Figure 3, in order to simplify the drawing. The manifold 19 is provided with a drive shaft 22 at one end and its other end is urged against the end of the housing 16 in a sealed relationship to facilitate rotation yet prevent liquid leakage. The manifold 19 is driven by means of a shaft 22, gear 24 and 25 and a motor 26. The motor 26 preferably operates in a stepwise fashion to ensure correct alignment of apertures 20 and conduits 27 in the housing 16 which are in fluid communication with the nozzles 14. A gear cover 28 is provided to protect the gears 24 and 25 from the harsh environments characteristic of most rolling mills.

Sealing means 29 having apertures 30 for each nozzle or cluster of nozzles 14 are provided between the exterior surface 32 of the cylindrical wall 21 and the inner surface 31 of the housing 16. The sealing means 29 prevent unwanted leakage of liquid to the nozzles 14 which should be closed, yet allow the passage of liquid from the inner chamber 33 defined by the manifold 19 through the conduits 27 to the nozzles 14 desired.

An alternative sealing means 34 shown in Figure 6 comprises a cylindrical tube 35 of appropriate material which lines a conduit 27 leading to its associated nozzles 14 and the end 36 of the tube 35 which is urged against the exterior surface 32 of the cylindrical wall 21. The conduit 27 lined with a tube 35 provides a leak-free passageway for fluid from the chamber 33 within the manifold 19 to the nozzles 14.

As shown more completely in Figure 7, in which the cylindrical wall 21 of the manifold 19 is shown as being slit longitudinally and flattened, the wall 21 is provided with an array of the apertures 20 so that, when the manifold 19 is rotated about its longitudinal axis, the appropriate apertures 20 can be aligned with the apertures 30 in the sealing means or element and the conduits 27 in the housing 16 and liquid may be thereby directed from the chamber 33 to the nozzles 14.

The particular view shown in Figure 7 is provided in order to illustrate the array of apertures 20 in the cylindrical wall 21. Only half the length of the cylindrical wall 21 is shown in this drawing, because the other half would be the mirror image of the first half. All the apertures 20 shown in Figure 7 have the same diameter, but in some instances it may be desirable to increase (or decrease) the diameter of certain of the apertures 20, in order to increase (or decrease) liquid flow to a particular nozzle or group of the nozzles 14. However, the diameters are chosen to allow the passage of liquid to the nozzles without significant pressure drop, so there are no undesirable differences in coolant flow from the various nozzles. A slot can replace several adjacent apertures.

Figure 8 shows a control panel face 40 divided into sectors 43 and provided with a selector knob 41 and a pointer 42. Each pie-shaped sector 43 of the circular control panel face 40 represents a spray width, the spray width dimensions decreasing clockwise from Sector A to Sector F. The sectors 43 are divided into subsectors 44 which represents the particular combination of opened or closed nozzles which give the desired spray pattern. Each annular segment 45 of one of the subsectors 44 represents a particular nozzle or cluster of nozzles 14. The shaded segments 46 indicate which of the nozzles 14 have been blocked off by the manifold wall 21. The nozzle grouping shown is only one-half of the spray bar, because the other half would merely be the mirror image of the first half. All twelve apertures 20 in the manifold wall 21 shown in Figure 7 are represented in the control panel face 40 shown in Figure 8.

In the operation of the spray bar 10, the selector knob 41 and the pointer 42 are turned to a particular subsector 44 which represents the desired combination of opened and closed nozzles 14. The motor 26 through the gears 24 and 25, rotates the manifold 19 in response thereto by means not shown, to position the manifold so that the apertures 20 are in alignment with the nozzles 14 which are to discharge liquid, while the nozzles 14 which are not to discharge liquid are blocked off by the cylindrical wall 21.

The coolant/lubricant requirements can vary during the rolling process, so several combinations (i.e. sections of subsectors 44) of sprays may be required to provide the desired cooling. For example, at the start of rolling, for a strip width represented by the Sector A, when the work rolls and backup rolls may not be at operating temperatures, Subsector A(3) would be selected to allow the work rolls to heat up and to develop the appropriate thermal expansion. The outside five nozzles on both sides and the fourth nozzle from the centre on both sides are turned on. When the desired roll shape is developed for normal operation, the selector knob 41 may be changed to subsector A(2), which causes the liquid flow from the fourth nozzles from the centre (both sides) to terminate and flow from the third and fifth nozzles from the centre to commence. During the normal rolling process, edge waviness or centre or quarter buckles may appear in the workpiece, indicating that undesirable thermal expansion has occurred in the mill rolls. The application of coolant/lubricant must be changed to minimize the undesirable expansion. When

centre buckle appears, for example, the problem may be minimized by changing the selector knob 41 to subsector A(1), which opens up all nozzles for coolant/lubricant flow. When the width of the sheet changes and the mill rolls are more or less at operating temperature levels, the selection of the particular subsector for initial operation may be bypassed and the subsector for normal operations for the particular workpiece width can be selected first.

Claims

1. A rolling mill having rolls (11) for use in the reduction in thickness of a metal workpiece (12) and including a liquid application device (10) which comprises an elongated housing (16) having a plurality of liquid spray nozzles (14) in fluid communication with conduits (15), an elongated manifold (19) rotatably mounted within the housing and having an arcuate wall (21) provided with a plurality of apertures (20) in a predetermined array and defining an inner chamber (33), sealing means (29) between the housing and the manifold, means for directing liquid to the chamber within the manifold and means (24, 25, 26) for rotating the manifold within the housing to align the desired apertures in the arcuate wall with the conduits, characterised in that

(a) the nozzles (14) are arranged to spray liquid on to a roll and/or on to the workpiece,

(b) the sealing means (29) are arranged between the conduits (15) and the outer surface of the arcuate wall (21) of the manifold and are operable for selectively sealing the liquid passageways to the conduits from the interior of the manifold, the sealing means comprising a sleeve (29) which fits over the manifold wall and includes a plurality of apertures (30) selectively alignable with the conduits normally in fluid communication with the nozzles,

(c) the manifold rotating means comprise a motor (26) for rotating the manifold and a control panel element (40) divided into a plurality of pie-shaped sectors (43) each representing a given width of liquid spray, the sectors being further subdivided into subsectors (44) which represent particular combinations of opened and closed nozzles which provide a selected spray pattern, and

(d) means (41, 42) associated with the panel element for selecting a given sector and thereby effecting a corresponding rotation of the motor and manifold as determined by the selected sector.

2. A rolling mill according to claim 1, wherein the subsectors are arranged to effect a progressive decrease in the spray width when projected in a clockwise direction and vice versa.

3. A rolling mill according to claim 1 or 2, wherein the motor is arranged to provide stepwise rotation of the manifold about its longitudinal axis.

4. A rolling mill according to claim 1, 2 or 3, wherein the arcuate wall of the manifold is of uniform thickness along its full length.

Patentansprüche

1. Walzwerk mit Walzen (11) zur Reduzierung der Dicke eines metallischen Werkstücks (12), mit einer Vorrichtung (10) zur Aufbringung von Flüssigkeit, welche aus einem länglichen Gehäuse (16) und einer Vielzahl von Sprühdüsen (14) besteht, welch letztere mit Leitungen (27) in Verbindung stehen, mit einer länglichen Verteilerleitung (19), die innerhalb des Gehäuses (16) drehbar gelagert ist und mit einer gekrümmten, mit einer Vielzahl von in einer bestimmten Verteilung angeordneten Öffnungen (20) versehenen Wandung (21) ausgerüstet ist, durch welche einer innere Kammer (33) umgrenzt wird, mit Dichtungsmitteln (29), die zwischen dem Gehäuse (16) und der Verteilerleitung (19) angeordnet sind, mit Mitteln zur Führung von Flüssigkeit in die Kammer (33) innerhalb der Verteilerleitung (19) und mit Mitteln (24, 25, 26) zur Drehung der Verteilerleitung (19) innerhalb des Gehäuses (16), um die jeweils gewünschten Öffnungen (20) der gekrümmten Wandung (21) mit den Leitungen (27) auszurichten, dadurch gekennzeichnet, daß

a) die Düsen (14) zum Sprühen von Flüssigkeit auf eine Walze und/oder das Werkstück angeordnet sind,

b) die Dichtungsmittel (29) zwischen den Leitungen (27) und der äußeren Oberfläche der gekrümmten Wandung (21) der Verteilerleitung (19) angeordnet und zum Wahlweisen Sperren eines Flüssigkeitsdurchtritts aus dem Innenraum der Verteilerleitung (19) zu den genannten Leitungen dienen, wobei die Dichtungsmittel aus einer die Wandung der Verteilerleitung (19) umgebenden Umhüllung (29) und einer Vielzahl von Öffnungen (30) bestehen, die wahlweise mit den Leitungen (27) in Verbindung bringbar sind, die normalerweise mit den Düsen (14) in einer einen Flüssigkeitsdurchtritt ermöglichenden Verbindung stehen,

c) die der Drehung der Verteilerleitung (19) dienenden Mittel aus einem Motor (26) zum Drehen der Verteilerleitung (19) und einem Schaltfeld (40) bestehen, welch letzteres in eine Vielzahl von tortenförmigen Sektoren (43) unterteilt ist, wobei jedem Sektor (43) eine bestimmte Srpühbreite zugeordnet ist, wobei die Sektoren (43) weiter in Untersektoren (44) unterteilt sind, deren jedem eine besondere, ein bestimmtes Sprühmuster darstellende Kombination von geöffneten und geschlossenen Düsen (14) zugeordnet ist,

d) und daß Schaltfeld (40) Mittel (41, 42) zur Auswahl eines bestimmten Sektors (43) zugeordnet sind, so daß sich eine, dem ausgewählten Sektor (43) entsprechende Drehung des Motors (26) und der Verteilerleitung (19) ergibt.

2. Walzwerk nach Anspruch 1, dadurch gekennzeichnet, daß die Untersektoren (44) derart angeordnet sind, daß sich—im Uhrzeigersinn fortschreitend—eine zunehmende Abnahme in der Sprühbreite ergibt und umgekehrt.

3. Walzwerk nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß mittels des Motors (26) die Verteilerleitung (19) schrittweise um ihre Längs-

achse drehbar ist.

4. Walzwerk nach einem der Ansprüche 1, 2 oder 3, dadurch gekennzeichnet, daß die gekrümmte Wandung der Verteilerleitung (19) über ihre gesamte Länge eine gleichförmige Dicke aufweist.

Revendications

1. Laminoir comportant des cylindres (11), destiné à être utilisé pour la réduction de l'épaisseur d'une pièce (12) en métal et comprenant un dispositif (10) d'application d'un liquide qui comporte un carter allongé (16) présentant plusieurs buses (14) de pulvérisation de liquide en communication de fluide avec des conduits (15), un collecteur allongé (19) monté rotatif dans le carter et ayant un paroi incurvée (21) comportant plusieurs ouvertures (20) disposées suivant un dessin prédéterminé et délimitant une chambre interne (33), des moyens d'étanchéité (29) entre le carter et le collecteur, des moyens pour diriger un liquide dans la chambre à l'intérieur du collecteur, et des moyens (24, 25, 26) pour entrainer le collecteur en rotation à l'intérieur du carter pour aligner les ouvertures désirées de la paroi incurvée avec les conduits, caractérisé en ce que (a) les buses (14) sont agencées pour pulvériser un liquide sur un cylindre et/ou la pièce à travailler, (b) les moyens d'étanchéité (29) sont agencés entre les conduits (15) et la surface externe de la paroi incurvée (21) du collecteur et agissent pour assurer sélectivement l'étanchéité des passages de liquide vers le conduits en provenance de l'intérieur du collecteur, ces moyens d'étanchéité comprenant un manchon (29) qui est ajusté par-dessus la paroi du collecteur et comprend plusieurs trous (20) pouvant être alignés sélectivement avec les conduits qui sont normalement en communication de fluide avec les buses, (c) les moyens d'entraînement du collecteur en rotation comprennent un moteur (26) pour entraîner le collecteur en rotation et un tableau de commande (40) divisé en une pluralité de secteurs (43) en forme de parts de tarte représentant chacun une largeur donnée de pulvérisation de liquide, ces secteurs étant en outre subdivisés en sous-secteurs (44) qui représentent des combinaisons particulières de buses ouvertes et fermées qui assurent un dessin choisi de pulvérisation et (d) des moyens (41, 42) associés au tableau pour sélectionner un secteur donné et effectuer ainsi une rotation correspondante du moteur et du collecteur telle que déterminée par le secteur choisi.

2. Laminoir suivant la revendication 1, dans lequel les sous-secteurs sont agencés de façon à effectuer une diminution progressive de la largeur de la pulvérisation lorsqu'elle est projetée dans le sens horaire, et inversement.

3. Laminoir suivant la revendication 1 ou 2, dans lequel le moteur est agencé pour assurer une rotation du collecteur pas à pas autour de son axe longitudinal.

4. Laminoir suivant la revendication 1, 2 ou 3, dans lequel la paroi incurvée du collecteur a une épaisseur uniforme sur la totalité de sa longueur.

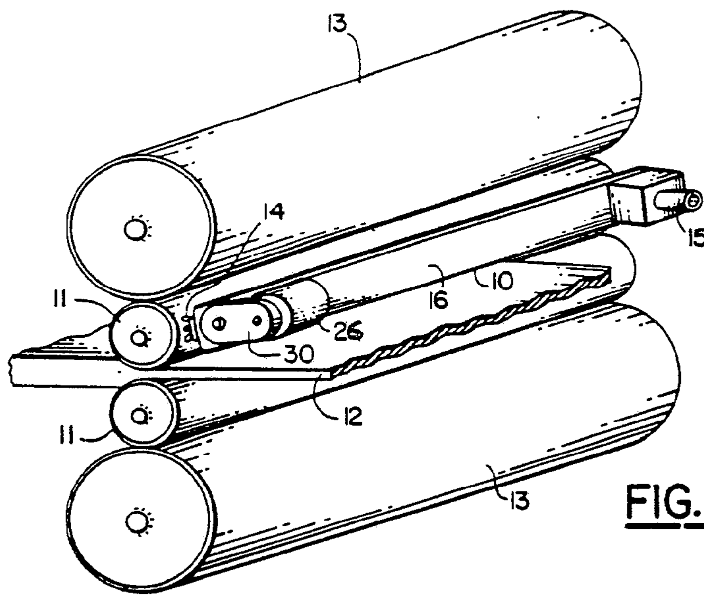

FIG. 1

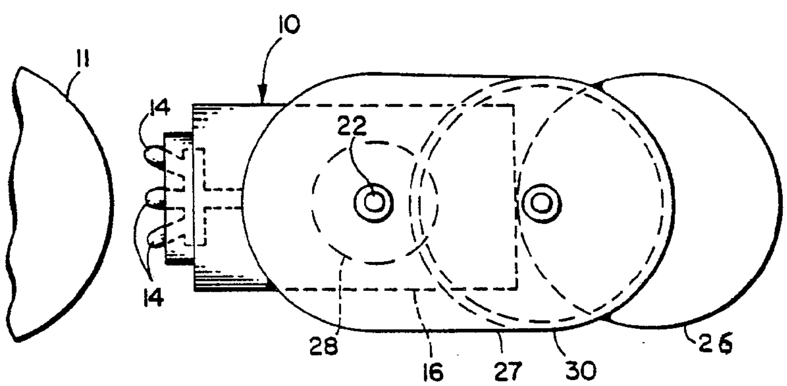

FIG. 2

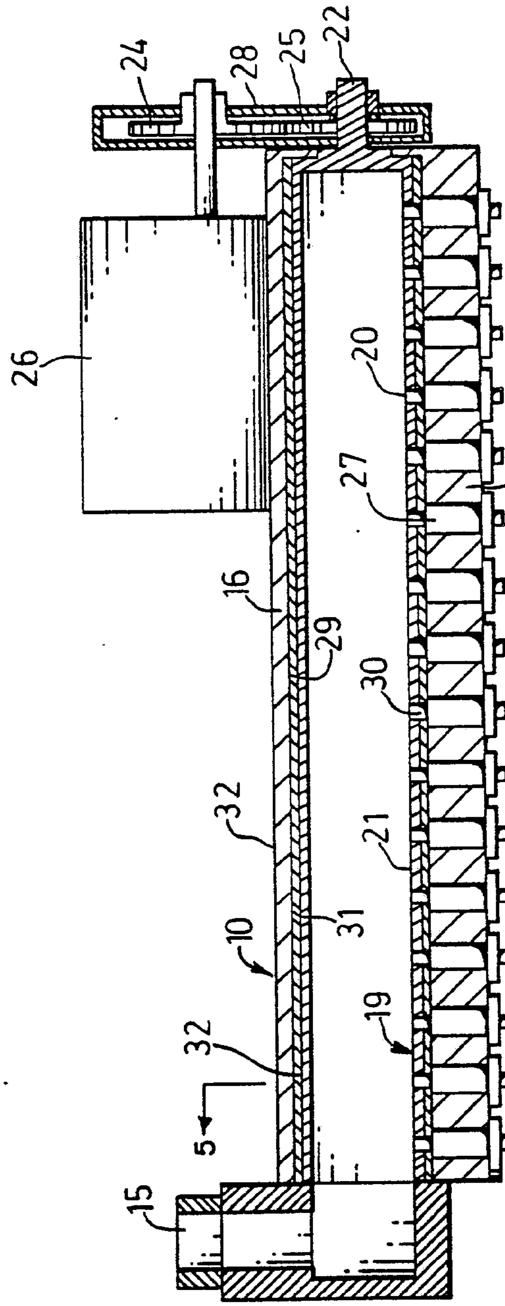
24
28
25
22
26
20
16
27
16
29
30
32
21
31
10
14
32
19
5
5
15

FIG.3

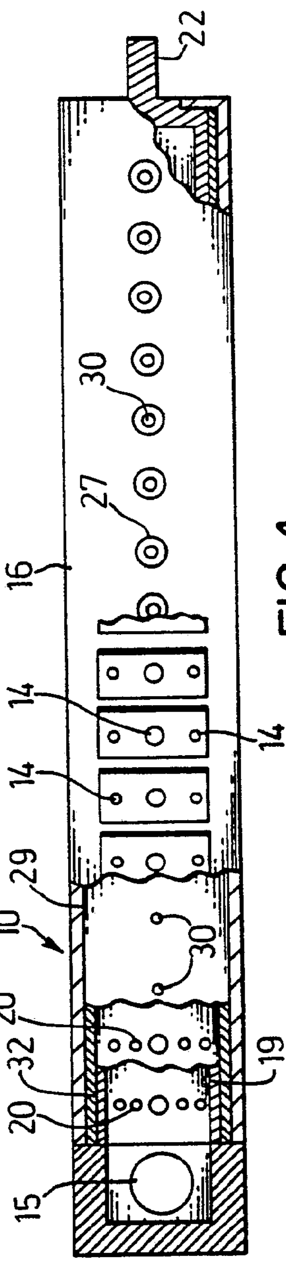
22
30
16
27
14
14
14
29
10
30
20
32
19
20
15

FIG.4

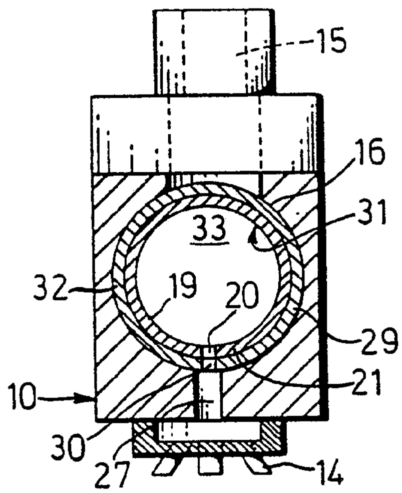

FIG. 5

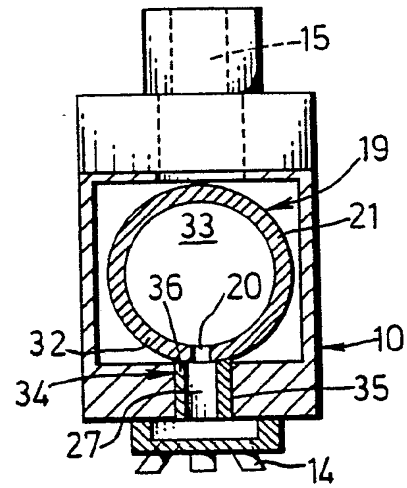

FIG. 6

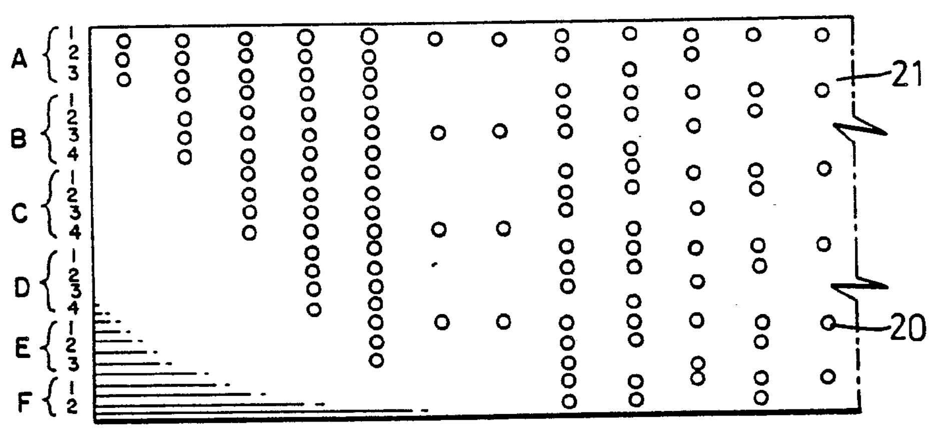

FIG. 7

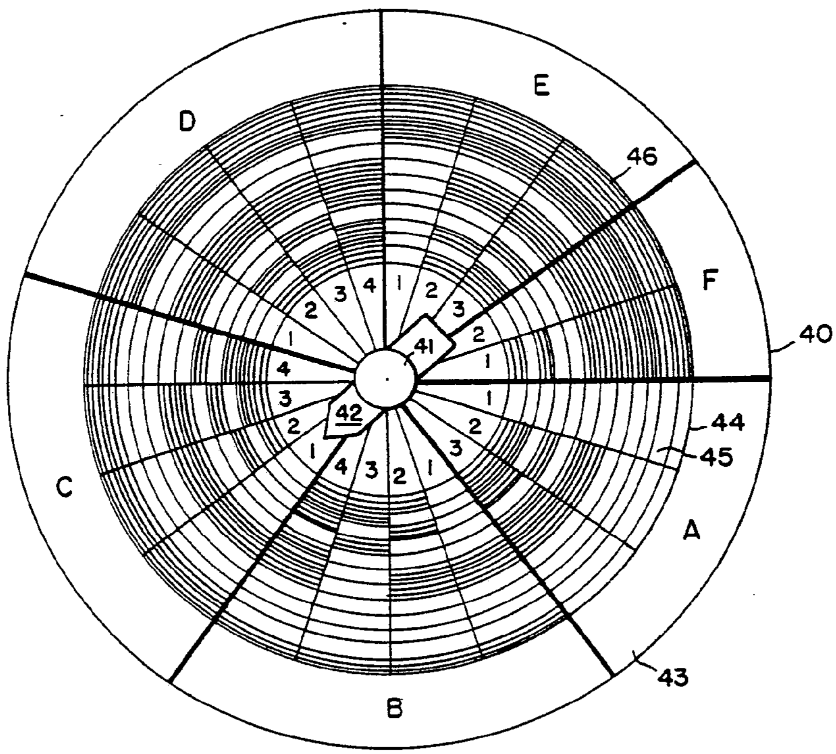

FIG. 8